METHODS AND APPARATUS FOR MAKING INTEGRATED CIRCUIT PACKAGE INCLUDING OPENING EXPOSING PORTION OF THE IC

Related Application

This application is based upon U.S. provisional application serial no. 60/225,972 filed August 17, 2001, the entire contents of which are incorporated herein by reference.

Field of the Invention

The present invention relates to the field of electronics, and, more particularly, to methods for making integrated circuit packages.

Background of the Invention

Integrated circuit (IC) devices or packages are used in a wide variety of electronic applications including computers, cellular telephones, entertainment systems, etc. A typical IC package includes a chip of semiconductor material, or IC, in which active electronic devices are formed. Surrounding the IC is an encapsulating material, such as typically formed of a thermosetting or thermoplastic resin compound. To protect the IC from damage or contamination, the encapsulating material typically totally surrounds the IC.

The IC itself may be carried by a leadframe. The leadframe includes a die pad which carries the IC, finger portions which provide the electrical pins extending outwardly from the encapsulating material, and die pad support bars which extend from the die pad to the finger portions. Contact pads on the surface of the IC are typically electrically connected to respective finger portions by bond wires which are surrounded by encapsulating material.

IC packaging has typically been concerned with protection and interconnects. Low cost, high volume manufacturing techniques are well established for conventional IC packaging. However, with the advent of various types of sensor, receiving, and/or transmitting circuits based on IC's, the need has arisen to expose some or most of the surface of the IC to the ambient environment. An example of such an IC device is an electric field fingerprint sensor, such as of the type described in U.S. Patent No. 5,963,679 to Setlak and U.S. Patent No. 5,862,248 to Salatino et al. Such sensors are available commercially from the assignee of these patents and the present invention, AuthenTec, Inc. of Melbourne, Florida.

The Salatino et al. patent, for example, discloses several approaches for molding the opening in the encapsulating material to expose the fingerprint sensing matrix. One approach uses a frame which holds a body of removable material in its interior and which is positioned on the IC before molding. After molding the body may be removed thereby producing the opening through the encapsulating material. In another embodiment, an upper mold includes a downward protruding portion which directly contacts the IC to exclude the encapsulating material from the surface of

the IC during injection molding to thereby form the opening exposing the IC.

Somewhat similar, a number of other patents disclose forming an opening in the encapsulating material from beneath the IC. Accordingly, cooling media may be circulated in the opening, such as disclosed in U.S. Patent No. 5,687,474 to Hamzehdoost et al. Similarly, U.S. Patent No. 5,570,272 to Variot provides a heatsink body in the opening beneath the IC. A pressure sensor is disclosed in U.S. Patent No. 5,424,249 to Ishibashi wherein the encapsulating material is first completely formed then an opening is cut therethrough to an underlying sensing diaphragm.

Methods for packaging IC's with an opening therein have generally been cumbersome and expensive, such as requiring specialized pre-made packaging and flexible or rigid printed circuit boards. These approaches are not well-suited to reliable, high volume, low cost manufacturing. Indeed, despite continuing significant developments, such as those described in the above noted Salatino et al. patent, a number of challenges are still presented for an IC package that exposes a portion of the IC. For example, it may be difficult to keep encapsulating material from bleeding under a mold protrusion that contacts the IC to form the opening. Preventing crush damage to the IC from foreign particles pressed between the mold and the IC also remains a challenge. Variations in the thicknesses of the IC's, adhesive layers, leadframes, etc. as well as accommodating IC skew also remains an area of concern.

Summary of the Invention

In view of the foregoing background, it is therefore an object of the present invention to provide

a method for making an IC package to have an exposed portion which is amenable to low cost, high reliability manufacturing.

In accordance with one embodiment of the invention, the method preferably comprises providing a mold including first and second mold portions, and wherein the first mold portion carries a mold protrusion defining an IC-contact surface with peripheral edges and a bleed-through retention channel positioned inwardly from the peripheral edges. The method also preferably includes closing the first and second mold portions around the IC and injecting encapsulating material into the mold to encapsulate the IC and make the IC package having the exposed portion of the IC adjacent the mold protrusion. Morever, the bleed-through retention channel retains any encapsulating material bleeding beneath the peripheral edges of the IC contact surface, and prevents the encapsulating material from reaching further onto the exposed portion of the IC. The method may also include releasing the IC package with the exposed portion from the mold.

The mold protrusion may comprise a resilient material, such as to prevent foreign particles from being crushed into the IC. The mold protrusion may have a generally rectangular shape and the bleed-through retention channel may extend along only portions or the entire extent of the peripheral edges. The first and second mold portions may each comprise rigid material. The method may further comprise periodically cleaning the mold and the mold protrusion.

The method may also include controlling pressure applied by the IC-contact surface to the IC when the first and second mold portions are closed around the IC. This may be done by providing the mold

protrusion to comprise compliant material. The material is preferably more compliant than the IC. The compliant mold protrusion may sufficiently control contact pressure that the IC may be mounted on a substrate, such as a printed circuit board, so that the substrate becomes the back of the package and prevents the encapsulating material from extending onto the back surface of the IC.

In other embodiments, the pressure may be controlled, at least in part, by mounting the IC on a leadframe having resilient portions to resiliently accommodate downsetting of the IC as the IC-contact surface contacts the IC. For example, the resilient portions may be die pad support bars extending between a die pad and finger portions of the leadframe. The downsetting may displace the die pad below the finger portions.

The method may also comprise shaping bond wires between the IC and the finger portions so that upon downsetting the bond wires have a desired clearance from adjacent portions of the IC and an upper surface of the encapsulating material. Accordingly shorts from contact with the die, or wires exposed through the encapsulating material are avoided.

Another aspect of the invention relates to stress relief since the encapsulating material and IC may have different coefficients of thermal expansion (CTEs). Accordingly, the method may further include relieving stress during cooling of the encapsulating material despite the different CTEs. For example, relieving the stress may comprise using a low stress encapsulating material. Alternately or additionally, relieving the stress may comprise providing a leadframe having a die pad with an opening therein, and mounting the IC on the die pad prior to closing the first and

second mold portions around the IC. In addition, the mounting of the IC on the die pad may comprise adhesively securing the IC on the die pad using a low stress, low modulus adhesive.

The IC may have an upper surface with active devices formed therein. Accordingly, the first mold portion may be an upper mold portion and may be closed adjacent the upper surface of the IC so that the exposed portion of the IC comprises at least a portion of the upper surface. For example, the active devices may define a sensor, such as an electric field fingerprint sensor.

Another aspect of the invention relates to a molding apparatus for making the IC package to have an exposed portion. The molding apparatus may comprise a mold including first and second mold portions being movable between closed and released positions. Moreover, the molding apparatus may include a mold protrusion carried by an interior of the first mold portion and defining an IC-contact surface with peripheral edges and a bleed-through retention channel positioned inwardly from the peripheral edges. Accordingly, upon injecting encapsulating material into the first and second mold portions in the closed position, the IC is encapsulated to make the IC package having the exposed portion of the IC adjacent the mold protrusion. The bleed-through retention channel retains any encapsulating material bleeding beneath the peripheral edges of the IC contact surface. In other embodiments, the mold protrusion may be more compliant than the IC, and the bleed-through retention channel may not be needed.

Brief Description of the Drawings

FIG. 1 is a perspective view of an exemplary fingerprint sensor IC package in accordance with the present invention.

FIG. 2 is a schematic cross-sectional view of the IC package as shown in FIG. 1 during manufacture.

FIG. 3 is an enlarged plan view of a portion of the leadframe as shown in FIG. 2.

FIGS. 4 and 5 are schematic partial side cross-sectional views during manufacture of the IC package as shown in FIG. 1.

FIG. 6 is a greatly enlarged schematic partial side cross-sectional view of the IC package during manufacture thereof after encapsulating material has been injected into the mold.

FIG. 7 is a flowchart of the method for manufacturing the IC package as shown in FIG. 1.

FIGS. 8 and 9 are schematic cross-sectional views of another embodiment of an IC package during manufacturing thereof.

FIG. 10 is a perspective view of the IC package as shown in FIGS. 8 and 9 upon completion.

Detailed Description of the Preferred Embodiments

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

For clarity of explanation, the present invention is explained with reference to manufacturing methods for making an IC package **30** in the illustrated form of an electric field fingerprint sensor IC package as shown in FIG. 1. The electric field fingerprint sensor IC package **30** may of the type using an electric field to sense the ridges and valleys of a fingerprint as offered by AuthenTec, Inc. of Melbourne, Florida under the designation FingerLoc™ AF-S2™.

The IC package **30** illustratively corresponds to a JEDEC-standard 68-pin plastic leaded chip carrier (PLCC) format, although other sizes, standards, and configurations are possible. The IC package **30** may be about 24 mm square, and have a height or thickness of about 3.5 mm, for example. Another exemplary package may be a 144 lead LQFP about 1.6 mm thick.

Further details on the operation of the electric field fingerprint sensor may be found in U.S. Patent Nos. 5,963,679 and 5,862,248 mentioned above, and, the entire disclosures of which are incorporated herein by reference. Of course, other sensors and other devices are also contemplated by the present invention.

The IC package **30** illustratively includes an IC chip or die **32** illustratively including an IC sensor matrix **31** which is exposed through an opening **36** in the upper portion of the encapsulating material **33**. Vestigial portions of encapsulating material may remain on the exposed portion of the IC **32**, outside the area of the sensor matrix **31**. These vestigial portions **39** are schematically indicated in FIG. 1 by the dashed line rectangle and these vestigial portions are described in greater detail below.

The IC package **30** also includes a leadframe on which the IC **32** is mounted as will be described in greater detail below. The leadframe includes a plurality of finger portions which become the visible leads or pins **37** which also extend outwardly from the sides of the encapsulating material **33** as will be appreciated by those of skill in the art. An annular drive ring **34** is provided on the upper surface of the encapsulating material **33** adjacent the opening **36** exposing the sensing matrix **31**. This drive ring **34** is specific to the illustrated electric field fingerprint sensor and is not needed in all such embodiments, or in other IC packages.

For ease of explanation, the term "IC" by itself is used primarily herein for simplicity to denote the actual integrated circuit die as will be appreciated by those of skill in the art. Also for ease of explanation, the term "IC package" is used to indicate the IC **32**, surrounding encapsulating material **33**, leadframe **35**, etc. as an entity.

Referring now additionally to the flowchart **50** of FIG. 7, and the schematic diagrams of FIGS. 2 through 5, further details of the manufacturing method and IC package **30** produced thereby are now described. From the start (Block **52**), an IC **32** is attached to a die pad **41** of the leadframe **35** at Block **54**. More particularly, as perhaps best understood with reference to FIGS. 2 and 3, the leadframe **35** includes a die pad **41** and finger portions **43** which are connected together at each corner by a respective resilient die pad support bar **44**. As will be appreciated by those skilled in the art, the finger portions **43** are later processed to form the visible leads **37** extending

outwardly from the encapsulating material **33** as shown in FIG. 1.

The die pad **41** of the leadframe **35** also illustratively has a central opening **42** therein. This opening **24** reduces stress during cooling of the encapsulating material **33** as will be described in greater detail below. A low stress, low modulus adhesive **49** may also be used to adhesively secure the IC **32** to the die pad **41** as will also be described in greater detail below.

At Block **56** the bond wires **45,** which extend between respective finger portions **43** and bond pads **46** of the IC **32,** are shaped to account for later downsetting. As shown best in FIGS. 2 and 4, the bond wires **45** are initially shaped so as to be angled downwardly at their upper ends. These upper ends will extend generally horizontally upon downsetting as shown best in FIGS. 5 and 6.

At Block **58** a mold is provided having first and second, or upper and lower mold portions **47, 48** as shown in FIG. 4. The first or upper mold portion **47** preferably carries a mold protrusion **70** defining an IC-contact surface **71** with peripheral edges and a bleed-through retention channel **72** positioned inwardly from the peripheral edges.

At Block **60** the upper and lower mold portions **47, 48** are closed around the IC **32.** As shown in the illustrated embodiment, the IC-contact surface **71** contacts and presses directly upon the upper surface of the IC **32** and causes the IC to be downset a distance **DS** as shown in FIG. 5. In other words, the resilient die pad support bars **44** permit the IC **32** to be contacted and moved downwardly to the position as shown in FIG. 5

so that the die pad **41** is displaced below the finger portions **43**. Accordingly, a close fit is provided between the IC **32** and contact surface **71** to prevent encapsulating material from bleeding extensively beneath the mold protrusion **70** and onto the surface of the IC **32**, and without crushing the IC.

The downsetting also accommodates skew of the IC surface and variations in thickness of the IC **32**, adhesive layer **49**, and/or portions of the leadframe **35** as will be readily appreciated by those skilled in the art. Considered in somewhat different terms, the manufacturing method includes controlling pressure applied by the IC-contact surface **71** to the IC **32** when the first and second mold portions **47**, **48** are closed around the IC. This may be done as shown in the illustrated embodiment by mounting the IC **32** on the leadframe **35** having resilient portions to resiliently accommodate downsetting of the IC as the IC-contact surface **71** contacts the IC. The resilient die pad support bars **44** as shown in the illustrated embodiment, for example, maintain a desired pressure placed on the IC **32** by the contact surface **71** of the mold protrusion **70** when the mold is closed. The die pad support bars **44** are placed in tension by the downsetting to provide a spring-like force or pressure to IC **32** against the contact surface **71** of the mold protrusion **70**. This pressure is controlled to avoid risk of damage while reducing likelihood of bleed-through of the encapsulating material **33** beneath the contact surface **71** as will be appreciated by those skilled in the art. Considered yet in other terms, the die pad **41** is essentially allowed to float during the molding process. The die pad support bars **44** can readily

accommodate tolerance variations of several thousandths of an inch and produce high quality IC packages.

The downsetting also aligns the bond wires **45** in a proper position to provide clearance from adjacent portions of the IC **32** as well as to provide clearance from the adjacent upper surface portions of the encapsulating material **33**. Accordingly shorts from contact with the IC **32**, or bond wires **45** being exposed through the encapsulating material **33** are avoided. As shown in the illustrated embodiment of FIG. 5, the bond wires **45** in the completed position after downsetting may have upper portions which extend generally horizontally away from the IC **32** before turning downward toward the finger portions **43** of the leadframe **35**.

At Block **62** the encapsulating material **33** is injected into the mold from the schematically illustrated injector **75** under controlled pressure. Those of skill in the art will appreciate detailed construction and operation of the encapsulating material injector **33** without further discussion herein.

As can be seen perhaps best in FIG. 6, a small bead or line of encapsulating material **33** may bleed under the peripheral edges of the mold protrusion **70** and remain as a vestigial portion **39** of the encapsulating material on the exposed surface of the IC **32**. As will be appreciated by those skilled in the art the relative size of the vestigial portions **39** is greatly exaggerated for clarity of illustration. In short, the bleed-through retention channel **72** retains any encapsulating material bleeding beneath the peripheral edges of the IC contact surface **71**.

It has been found that a flat contact surface of a mold protrusion alone is not likely to reliably

prevent the encapsulating material **33** from wicking along the interface between the contact surface **71** and the IC **32**. It is also likely that typical mold clamping pressures cannot be exerted on the IC **32** without considerable risk of damage. Because the clamping pressure is typically lowered, the potential for bleed-through or wicking of the encapsulating material becomes more important. Accordingly, the bleed-through retention channel **72** may be considered as providing a moat to act as a natural break for the bleeding of the encapsulating material **33** during molding.

The mold protrusion **70** may comprise a resilient material, and have a generally rectangular shape having a side dimension of about 5 to 20 mm for an IC package **30** having a side dimension of about 25 mm, for example. The bleed-through retention channel **72** may be spaced inwardly from the peripheral edges a distance of about 0.2 to 0.4 mm, for example. The retention channel **72** may also have a width of about 1 mm, and a height of about 0.15 to 0.25 mm. Those of skill in the art will appreciate that other sizes are also contemplated by the present invention depending on the application and the size of the IC package.

The IC package **30**, that is, the IC **32**, leadframe **35**, and encapsulating material **33** may be released from the mold at Block **64** before stopping at Block **66**. Those of skill in the art will appreciate that other finishing steps, including trimming excess encapsulating material, and separating the finger portions, for example, are also typically performed to produce the finished IC package **30**.

Another aspect of the manufacturing relates to stress relief. Stress relief may be important since

the encapsulating material **33** and the IC **32** typically have different coefficients of thermal expansion (CTEs). It is noted that the leadframe **35** may also have a different CTE. Accordingly, the manufacturing method preferably includes relieving stress during cooling of the encapsulating material **33** despite the different CTEs. The IC package **30** will have an unbalance of thermal-mechanical stress because of the opening **36**. This is in contrast to the balanced stress which results in a balanced compressive force experienced by an IC in a typical fully encapsulated IC.

For example, relieving the stress may comprise using a low stress encapsulating material **33**. For example, the encapsulating material **33** may be a mold compound sold under the designation Plaskon SMT-B1-LV by Cookson Semiconductor Packaging Materials of Alpharetta, Georgia. Those of skill in the art will appreciate that other similar mold compounds may be used as well. Alternately or additionally, stress relief may be provided by using a leadframe **35**, such as illustrated and described herein, which includes the die pad **41** with the opening **42** therein. The IC **32** may also be mounted on the die pad **41** using a low stress, low modulus adhesive **49**. For example, the die attach adhesive **49** may be an adhesive sold under the designation Ablebond 8340, and manufactured by Ablestick Electronics Materials and Adhesives (National Starch and Chemical Co.) of Rancho Dominguez, CA. The low stress, low modulus adhesive **49** and/or open die pad **41** tends to decouple the IC **32** from the leadframe **35** which may typically comprise copper.

As described herein, the IC **32** may have an upper surface with active devices formed therein, such

as the illustrated fingerprint sensor with the pixel element matrix **31**. Of course, those of skill in the art will appreciate that the techniques described herein could also be used to expose the back or underside of an IC.

The first and second mold portions **47, 48** may each comprise a rigid material, such as hardened steel, to provide accurate dimensions and to resist abrasion from the encapsulating material **33**. Although the molding process is relatively clean, small particles may be left on the top of the IC **32** or on the contact surface **71** of the mold protrusion **70** as will be readily appreciated by those skilled in the art. In contrast to the mold portions **47, 48,** the mold protrusion **70** may comprise a compliant or resilient material so that any contaminants are not forced into the IC **32** causing damage. The material properties of the mold protrusion **70** are desirably such that any small particles will be pressed into the contact surface **71** instead of into the IC **32**. However, it is still desired that the mold protrusion **70** retain its shape through the molding process. The mold tooling is also preferably such as to permit removal of the mold protrusion **70** for cleaning and/or replacement if worn or damaged as will also be appreciated by those skilled in the art.

One attribute of the molding process is that the mold will acquire a build-up of encapsulating material and wax material that may produce aesthetic problems in the finished IC package. Accordingly, mold cleaning is typically performed at periodic intervals. A conventional mold cleaning process entails molding a plastic gettering material, such as melamine, that will adhere to any organic material. After a few molding cycles using the gettering material, normal production

is continued. The melamine has a high adhesion to organic particles, but low adhesion to hardened steel mold surfaces.

The mold protrusion **70** can be made of any of a number of appropriate materials. If the mold protrusion **70** is formed of an organic polymer, precautions may be needed to clean the mold, as the conventional melamine cleaning process could potentially damage the compliant mold protrusion by sticking to it and pulling it apart. Several approaches may be used to alleviate this potential difficulty. The organic polymer mold protrusion **70** can be temporarily replaced with a corresponding metal insert during melamine cleaning, for example. A metal or non-stick cap or non-stick coating could be provided over the organic polymer mold protrusion **70**.

Returning again to FIGS. 1 through 6, it can be appreciated that the IC package **30** produced using the advantageous processes described herein will have certain distinguishing features and characteristics. For example, in one class of embodiments, in view of the manufacturing approach, vestigial portions **39** of encapsulating material **33** are left on the exposed portion **31** of the IC **32** and spaced inwardly from a periphery of the opening **36** in the encapsulating material. Of course, these vestigial portions **39** could be removed in some embodiments if desired, but simpler and less expensive manufacturing is obtained if the vestigial portions do not effect IC operation and are, therefore, allowed to remain on the IC **32**.

As described herein, the opening **36** in the encapsulating material **33** may be generally rectangular. For these embodiments the vestigial portions **39** of encapsulating material are arranged along an imaginary

rectangle spaced inwardly from the generally rectangular opening in the encapsulating material. It should be noted that the vestigial portions **39** need not necessarily be connected to form a complete rectangle, rather, the vestigial portions may be spaced, but lie along an imaginary rectangle as defined by the bleed-through retention channel **72** of the mold protrusion **70**. For example, the vestigial portions may be spaced inwardly a distance of from 0.1 to 3 mm for an IC package having side dimensions of about 25 mm. Of course, the same principles can be readily applied to other polygonal, round, or other closed geometric shapes as will be appreciated by those skilled in the art.

Another characteristic of the IC package **30** resulting from manufacture as described herein is the downset relationship of the die pad **41** relative to the finger portions **43**. The die pad support bars **44** may also be resiliently deformed to accommodate the downset of the die pad **41**. In addition, the bond wires **45** will also likely have a desired clearance from adjacent portions of the IC **32** and an upper surface of the encapsulating material **33** when the die pad **41** is downset.

As also described herein, to reduce stress during cooling, the die pad **41** (FIG. 3) may have an opening **42** therein. Further, a low stress, low modulus adhesive **49** may be used to secure the IC to the die pad **41**. The encapsulating material **33** may also be a low stress encapsulating material.

The IC **32** may include upper surface portions with active devices formed therein, such as fingerprint sensing circuitry. The exposed portion of the IC may comprise these upper surface portions. In some

advantageous embodiments, the active devices may define a sensor, such as an electric field fingerprint sensor, for example. Other devices may be similarly packaged as will be also readily understood by those skilled in the art.

Turning now additionally to FIGS. 8-10, another embodiment of an IC package **80** and its method of manufacture are now described. As shown in FIG. 8, the IC **81** is adhesively secured to a substrate **84**, which may be a printed circuit board, for example. For clarity of explanation, the layer of adhesive is not shown, but may be of the type described above, for example. The substrate **84** may be rigid in some embodiments, but can also be flexible in other embodiments. The substrate **84** may be a ball grid array substrate, or be of the type that with further processing will become a ball grid array substrate. Other substrate types are also contemplated by the invention. In other words, in this IC package **80** the leadframe **35** for mounting the IC and described extensively above is replaced with the substrate **84**.

In the illustrated embodiment, the bond pads **82** are also along only one side of the IC **81**, and, accordingly, the bond wires **83** are also along only one side of the IC **81**. Those of skill in the art will recognize that in other embodiments, the bond pads **82** could be along two, three or all four sides in other embodiments.

The IC **81** and substrate **84** are placed between a lower mold portion **85** and an upper mold portion **86** as shown in FIG. 9, and encapsulating material **91** is injected under controlled pressure. A mold protrusion **87** is provided adjacent the upper mold portion **86**. The mold protrusion **87** is desirably relatively compliant so

as not to crush foreign particles into the IC **81.** Further, in this embodiment, since downsetting of a leadframe **35** is not used to accommodate variations in thicknesses, the compliancy of the mold protrusion **87** accommodates any variations, such as in the thickness of the substrate **84,** adhesive layer and/or IC **81.** In one example, the mold protrusion **87** may comprise a solid body of Teflon, for example. As will be seen below, because there is no encapsulating material **91** injected under pressure beneath the IC **81,** a more compliant mold protrusion **87** may be used than compared, for example, to the embodiments described above using the leadframe **35.**

The upper mold portion **86** may be provided as two portions which mate at the illustrated dashed line **88.** In other words the upper mold portion **86** may include a changeable cavity plate at the level of the dashed line **88** so that this plate may be changed to accommodate different sized packages as will be appreciated by those skilled in the art.

In this illustrated embodiment, it is further noted that the bleed-through retention channel **90** in the mold protrusion **87** is only along the right hand side of the IC **81.** This is so because the encapsulating material **91** will extend onto the upper surface of the IC **81** to cover the bond pads **82** and bond wires **83** on the right hand side. On the lefthand side it can be seen that the encapsulating material **91** does not extend onto the upper surface, and bleed through of the encapsulating material can be controlled since the mold protrusion **87** extends completely over the upper surface and slightly beyond. Those of skill in the art will appreciate that in other embodiments, the mold

protrusion **87** could also be made or configured to have the bleed-through retention channel **90** extend on two, three or all four sides.

The finished IC package **80** is shown in FIG. 10 wherein an upper surface **92** of the IC **81** is exposed through the opening **93** in the encapsulating material **91**. In this illustrated embodiment, the substrate **84** extends outwardly beyond the side edges of the IC **81**. In other embodiments, the side edges of the substrate **84** may be terminated flush with the side edges of the IC **81** as will be appreciated by those skilled in the art. The vestigial portions **95** of encapsulating material **91** are also schematically illustrated by the dashed line on the right hand side of the upper surface **92** of the IC **81**.

It is further noted that although the encapsulating material **91** surrounds the IC **81**, there is no encapsulating material **91** on the back surface of the IC in the illustrated IC package **80**. In this embodiment, the substrate **84** provides the protection for the back surface.

Other aspects of the invention are disclosed in U.S. Patent Application Serial No. ______________, entitled "INTEGRATED CIRCUIT PACKAGE INCLUDING OPENING EXPOSING PORTION OF AN IC"(having attorney work docket no. 51571) filed concurrently herewith. The entire contents of this application are incorporated herein by reference. In addition, many modifications and other embodiments of the invention will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Accordingly, it is understood that the invention is not to be limited to the illustrated embodiments disclosed, and that other

modifications and embodiments are intended to be included within the spirit and scope of the appended claims.